Clinical assessment of patients with intermittent claudication

Kliniczne metody oceny pacjentów z chromaniem przestankowym

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Key words
intermittent claudication, functional tests, quality of life

Abstract
In this work there are presented different methods of clinical analysis of patients with intermittent claudication. The methods contain haemodynamic measurements, an assessment of physiological parameters, an assessment of the physical abilities of a patient and questionnaires' assessment. These methods are used for diagnosis of intermittent claudication, the evaluation of patients' condition after therapy as well as for describing patients' functional performance and their quality of living. Because of the heterogenic character of patients with intermittent claudication and their serious limitations in personal, vocational and social life, the parameters used for patient's characterization have to be reliable, complex, describing not only the progress of the disease but also its influence on everyday life and quality of life. Isolated haemodynamic measurements are not a proper method of a patient's evaluation, their values do not correlate with the functional performance of patients. Similarly, the improvement of physical abilities that is seen during trainings, is not always visible in the values of the haemodynamic parameters. These reasons indicate that a complex clinical analysis of different parameters in patients with intermittent claudication is strongly advisable. The aim of this study was to assess the effectiveness of the most common methods that are used in the diagnosis of patients suffering from intermittent claudication, with the indication of those that may be the most important for clinical and scientific research.

Słowa kluczowe
chromanie przestankowe, testy funkcjonalne, jakość życia

Streszczenie
W pracy przedstawiono wybrane metody oceny klinicznej pacjentów z chromaniem przestankowym. Metody te obejmują podstawowe pomiary hemodynamiczne, ocenę możliwości fizycznych pacjenta oraz badania kwestionariuszowe. Stosowane badania służą zarówno diagnostyce chromania, jak również ocenie skuteczności stosowanej terapii, a także charakteryzują stan funkcjonalny i jakość życia chorych. Heterogenny charakter opisywanej grupy pacjentów oraz związane z chorobą znaczne ograniczenie aktywnego uczestnictwa chorego w życiu społecznym i zawodowym wymaga użycia miar rzetelnych, całościowo opisujących stopień zaawansowania choroby, jak również jej wpływ na codzienne funkcjonowanie i jakość życia pacjentów. Na ogół odosobnione pomiary hemodynamiczne nie są właściwą metodą oceny a ich wartości nie korelują z możliwościami funkcjonalnymi pacjentów z chromaniem przestankowym. Podobnie, poprawa możliwości wysiłkowych, obserwowana podczas treningu, nie zawsze odzwierciedla się w poprawie wartości parametrów hemodynamicznych. Stąd też, w diagnostyce chorych z chromaniem przestankowym zaleca się stosowanie złożonych metod oceny. Celem pracy była zarówno ocena skuteczności metod najczęściej stosowanych w diagnostyce chorych z chromaniem przestankowym, jak i próba wskazania najbardziej przydatnych, zarówno dla celów klinicznych jak i badań naukowych.

INTRODUCTION

Intermittent claudication (Latin *claudicatio intermittens*) is characterised by pain in the muscles of the lower limbs occurring during walking. This pain forces the sufferer to terminate the exertion and to stop movement. This is the result of an insufficient oxygen supply under conditions of exertion resulting from a narrowing or occlusion of the artery in the course of peripheral arterial disease (PAD) of the lower limbs.[1] Restricted exercise ability accompanies a decrease in patient activity both in the house, work, as equally during free time, which results in a noticeable reduction in quality of

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Table 1

Classification of peripheral arterial disease of the lower limbs (PAD)

Rutherford			ABI (ankle-brachial index)	Fontaine	
Degree	**Category**	**Clinical symptoms**		**Degree**	**Clinical symptoms**
0	0	lack of subjective symptoms	0.90- 0.7 mild PAD	I	lack of subjective symptoms
I	1	mild claudication		IIA	mild claudication
I	2	moderate claudication	0.69–0.41 moderate PAD	IIB	moderate claudication to severe
I	3	severe claudication			
II	4	rest pain	≤ 0.4 severe PAD (critical ischaemia)	III	rest pain
III	5	small degree of tissue damage	< 0.20	IV	ulceration, necrosis
III	6	large degree of tissue damage			

On the basis of the reports of the Trans Atlantic Inter-Society Consensus (TASC II) ,[11] American Diabetes Association (ADA)[76] and W. R. Hiatt[77]
ABI – ankle-brachial index

life[2,3]. However, this is not the fundamental problem in this group of patients, for the relatively mild problem that is intermittent claudication is most often a symptom of a generally occurring atherosclerosis process, the consequence of which is a high mortality rate chiefly as a result of heart attacks and strokes occurring after 5, 10 and 15 years from diagnosis being respectively 30%, 50% and 70%[4]. For this reason the question of an accurate and quick diagnosis, as equally the evaluation of the progress being made by treatment and the appropriate later monitoring of patients with intermittent claudication, is an important clinical matter. Yet this most common symptom of PAD of the lower limbs is usually disregarded by patients and the symptoms treated as being muscular-skeletal in nature or connected with the process of the aging of the organism[5]. Equally doctors' awareness of this problem is surprisingly low. Hirsch et al.[6] show that only 49% of surveyed doctors knew that their patients had previously had diagnosed PAD of the lower limbs in relation to 83% of patients being conscious of their illness. As the PAD progresses so rest pains occur, localised in the foot, most often at night and when the legs are raised. At later stages of advancement in PAD of the lower limbs there result ischemic changes: ulcerations and necrosis[7]. We have employed Fontaine's classification or more exactly Rutherford's (Table 1) in the evaluation of the degree of disease advancement. The evaluation of the functional possibilities of the patient and the degree of disease advancement, as equally the evaluation of progress in treatment requires both practical methods as those objectively describing the patient's state. The procedures employed should be precise, enabling reproducible results[8], and should also incorporate a wide range of complaints connected with intermittent claudication as a result of the heterogenic character of the patient group[2]. Besides which it is expected that the methods applied were well tolerated by patients, accessible and simple in application as well as being relatively inexpensive[9].

The work presents methods for the clinical evaluation of patients with intermittent claudication with particular attention being devoted to functional diagnostics. Equally are discussed the basic non-invasive hemodynamic measurements that are possible for a physiotherapist to conduct and which constitute the basic diagnostic instruments as well as being an integral component of the exercise tests applied in patients with intermittent claudication.

HEMODYNAMIC MEASUREMENTS

The Ankle–Brachial Index (ABI) is the basic non-invasive hemodynamic test used on patients with intermittent claudication ABI is calculated by dividing the results of blood pressure measurements at the level of the ankles in the lower limbs by the blood pressure at the brachial artery, on the side where the blood pressure is higher. The correct value of the indicator should be greater than 1, although 0.9 is accepted as the point differentiating correct values from the incorrect[1,10,11]. The ABI demarcation is considered the best method for the identification of peripheral arteries disease of the lower extremities[12]. A regularity has been observed that patients with an ABI index of < 0.8 experience intermittent claudication while with an ABI of < 0.3 they experience pain in the lower limb at rest (Table 1)[12]. High values of ABI (over 1.4) are considered to be unreliable. Most often such a result is connected with rigid, calcified arteries, which may occur in patients with diabetes and renal failure[11,12]. ABI in accordance with the recommendations of TASC II (*TransAtlantic Inter-Society Consensus*)[11] should be routinely denoted in all patients aged 50–69 with symptoms of exertion pain of the lower limbs with factors of cardio-vascular disease development (diabetes, a case history of smoking) as well as patients over the age of seventy regardless of whether risk factors appear. Unfortunately the ABI is relatively poorly correlated with an increase in the walking distance obtained during the course of physical training, more than likely as a result of the complexity of the mechanisms leading to its improvement. Therefore it follows to remember that its low value cannot be the main criteria in the qualifying of a patient for vascular

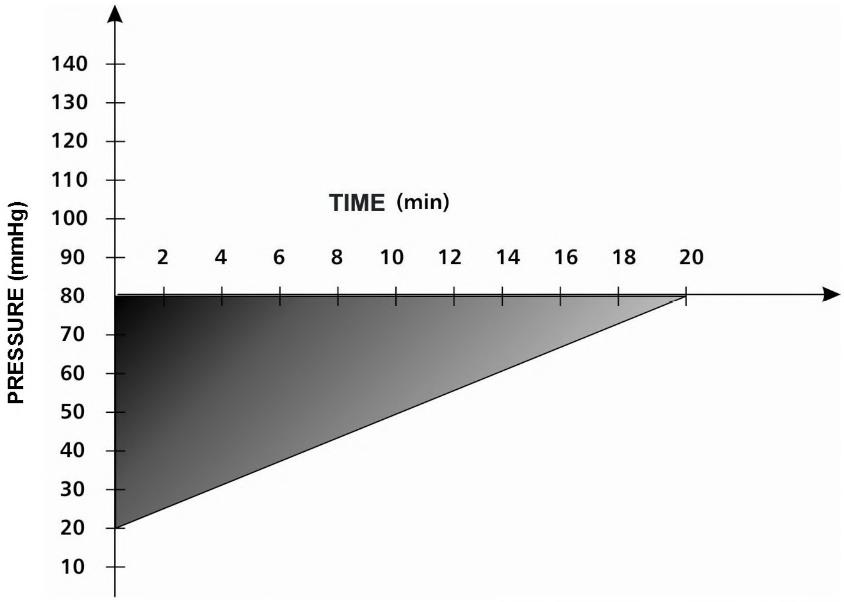

Figure 1
Changes in systolic pressure at ankle level in the minutes subsequent to exertion
The shaded area represents the magnitude of the ischemic window

procedures. On the other hand in patients with intermittent claudication, in whom there appears isolated stenosis of the iliac artery, there may not occur a reduction in the arterial blood pressure at rest and the ABI may be correct[11]. The ABI measurement provides important information in conditions of physical exertion, which means that even small changes in the arteries become hemodynamically significant. Therefore it is recommended to combine ABI tests with a walking test[13]. A fall in the ABI value by 15-20% following exercise indicates peripheral circulatory failure[11,12]. Hemodynamic measurements are conducted therefore in patients at a state of rest as well as following physical exercise, for example after a treadmill walking exercise. The lowest values of ABI indicators as well as systolic pressure occur in the first minute following exercise and may continue for even 8-10 minutes[14]. Ischemia may be also simulated by the closing of arterial flow by means of a blood pressure cuff applied to the upper part of the leg and pumped up to above the systolic pressure. The occurring ischemic deficit is described as a so-called ischemic *window*[15] and is presented graphically as a field; the magnitude of which is the function of the post-exercise fall in blood pressure at the level of the ankles (of the ABI indicator) in the ischemic limbs and the time of the return of the parameters to the initial value following the completion of exercise (Figure 1). The ischemic *window* well illustrates the ischemic deficiencies occurring in physical exertion as well as supplying reproducible objective data on the subject of improvement in the functional state of patients undergoing treatment[13,15,16].

Segmentary measurements of systolic pressure are carried out with the aid of a Doppler head and specially designated blood pressure cuffs placed along the entire length of the limb (the upper part of the leg, above the knee, the shank, above the ankle). The magnitude of blood pressure fall defines the degree of intensification in the changes within the circulatory system as well as helping to establish the locations of stenosis in the large arteries.[1,10].

The indicator of systolic pressure in the hallux, is helpful in the evaluation of healing potential. It is more often used with individuals with diabetes or with critical ischemia of the limbs than in patients with claudication.

From amongst the remaining non-invasive diagnostic methods used in patients PAD of the lower limbs it follows to mention ultrasonography testing, magnetic resonance angiography (MRA), computer tomography angiography (CTA) and also the measurement of flow waves by means of the Doppler method and the registration of arterial volume[17]. However, none of the above methods correlate well with the functional state or equally with the amount of limitation experienced in daily life by patients with intermittent claudication. Besides, the improvement in exercise possibilities observed in patients can equally not be correlated with the beneficial changes in the area of hemodynamic parameters. Therefore equally isolated hemodynamic measurements are not an appropriate method of evaluation in this group of patients[2,18]. Also significant is the testing of the functional possibilities of a patient and the limitation to quality of life. A patient with intermittent claudication despite a low ABI may have well developed peripheral circulation, which in conditions of exertion of a low intensity will be able to satisfy the oxygen metabolism of the muscles of the lower limbs. Only an increase in the intensity of exercise results in a disturbance in this balance and the occurrence of muscular pain. Therefore an accurate estimation of physical possibilities has equally a significant meaning, particularly in the aspect of an evaluation of progress in treatment.

EVALUATION OF PHYSICAL PERFORMANCE

Most often evaluation of a patient's physical performance is conducted by means of walking tests. Tests conducted on treadmill are also applied, as well as without a treadmill on a flat surface (corridor). A cycloergometer is also used in evaluating the physical possibilities of patients with intermittent claudication, as well as the application of other methods for objective and subjective functional diagnostics.

Ergometric tests

Walking test on a treadmill with a constant load. The load is a constant speed (most often 3.2 km/h) and the incline angle (in various works from 0-12%). The distance to the appearance of pain (*ICD – initial claudication distance*) and the maximum intensity of pain, when the walk is terminated are evaluated (*ACD – abso-*

lute claudication distance). The recurrence of the results expressed as an ICC value (ICC *intraclass correlation coefficient*) in a test at a speed of 2.4 km/h and 7.5% incline of the treadmill are determined by Gardner et al.[14] as 0.53 for ICD and 0.55 for ACD. The variability of the test with constant load, valued with the CV (*coefficient of variance*), is most often estimated as 30% for ACD and 40% for ICD[19,20]. Such a sizeable variance often requires the test to be repeated several times for individual patients. Degischer et al.[21], in comparing various protocols with constant load (speed: 2 km/h, 3.2 km/h, 4.0 km/h as well as a treadmill incline of 0% or 12%), point to the increasing recurrence of measurements in the division 0.61–0.95 for ACD in conjunction with an increasing load. The highest ICC=0.952 was obtained for ACD at a speed of 4 km/h and 12% of treadmill gradient, equally this test showed the lowest variability in the measurement of ACD where the CV barely reached 9.7%. In control tests, during the evaluation of functional possibilities following the completion of the programme, it was observed that patients from the control group displayed also an unexpected improvement in the maximum walking distance at a range of 36% for ICD and 25% for ACD[18,22]. Such an increase in the walking distance, not being a result of training, makes the possibility to evaluate the effects of therapy more difficult. Possibly the cause if the observed improvement was a change in the biomechanics of gait during the repeated conduction of the test (the so-called learning effect). These changes, independent of treatment, should be taken into consideration when undertaking a statistical analysis of each test based on a walking test with constant load[2,18]. Additionally, in order to obtain statistically reliable results it is considered that the size of the experimental group and the control group should not be less than 98 patients in those tests employing the test with constant load. It is estimated that this adaptive period should not be shorter than 6 minutes[23].

The load and gradient of the treadmill are usually individually selected for each patient at the beginning of the test, so as for it to be sufficient to end the attempt as a result of the maximum intensification of pain in the lower limbs. As a result of the diversity in the walking possibilities of patients it is difficult to select invariable optimal parameters for their testing. If the degree of treadmill incline is too great, many patients experience pain very early on and are unable to produce a reliable test result. On the other hand, too low a treadmill incline angle in fitter patients may not cause pain induced problems and the test is stopped for reasons other than the pain of claudication[2,18]. Such a situation may also occur when improvement in the walking distance following treatment is evaluated, for example through physical training. The initial intensity of effort on the treadmill, which was sufficient for the ACD measurement, may occur to be too small after therapy to stop the walk as a result of the maximum intensification of muscular pain of the lower limbs. This problem may be resolved by selecting the initial load (the treadmill incline gradient) so that ACD is obtained in a relatively short time e.g. around 5 minutes. However, the risk of there being an absence of a precise designation of the magnitude of walking distance improvement in such a patient group, although not reducing the clinical value of the method itself, results in it becoming of little value for scientific purposes.

Despite the above limitations, testing with constant load is a frequently research instrument, one well tolerated by patients. It is a more natural form of physical activity in comparison with a test with increasing resistance and enables an easier expression of the improvement obtained, for example, in the course of physical training in the form of an increase in the time or distance of the walk. A treadmill is a piece of generally available equipment, while the conducting of the test itself requires the minimum of preparation. Testing has been for the last 40 years, despite its inaccuracies, the main form of clinical evaluation of patients with intermittent claudication[2,18]. However, in applying a test with a constant load it follows to remember not only about the necessity for an earlier, practical acquaintance on the part of the patient with this form of movement, but also - as a result of the large variability in the results obtained - it is recommended that it is conducted several times. Usually the best result is taken for analysis. In applying a test with constant load for scientific purposes it is additionally necessary to ensure a respectively numerical patient group.

Walking test on a treadmill with increasing load. Initially developed by Bruce et al. in the 1960s[24], it served in the evaluation of cardiological patients. The research protocols were personally expanded and adapted for the evaluation of patients with claudication by Gardner and Hiatt[18]. In both protocols the walking speed is constant and represents 2 mph (3.2 km/h) while the treadmill incline angle is increased by 3.5% every three minutes or by 2% every 2 minutes. As a result of equipment limitation (in the majority of treadmill the angle changes every 1%) more practical in application is Gardner's protocol. Both ICD and ACD are evaluated. Both in the test with a constant load as equally an increasing one, the pain complaints connected with claudication are assessed by using a five-degree scale of pain intensification. Widely in use is the scale of the American College of Sport Medicine (ACSM)[25] as well as that proposed by Regensteiner et al.[26] (Table 2).

This means of testing is characterised by a noticeably greater accuracy in comparison with tests with a constant load. It is estimated that the CV is located within the division 15%-25% for ICD as well as 12%-13% for ACD[14]. While Gardner et al.[14] point to the high reproducibility of results in their protocol, reaching 0.89 for ICD and 0.93 for ACD. It is emphasised that a gradual treadmill test is useful for patients with various symptoms of claudication, incorporating patients over the age of 70[2,27] as well as those with a low ABI index value[5,27]. Nevertheless Riebe et al.[28] propose the use within a patient group with low physical fitness of a gradual test starting with a low speed beginning at 1.6 km/h and an incline of 5%. Subsequently, every 5 minutes, the speed of the walk in increased by 0.8 km/h with a constant 10% angle of incline. After 20 minutes of walking the incline angle increases to 15% while the achieved speed of 4 km/h is main-

Table 2

Frequently used scales for assessing patient's level of claudication

	Severity of claudication pain				
Gardner *(ACSM)*	0	1	2	3	4
	no pain	onset of pain	moderate pain (from which it is possible to divert the patient's attention)	intense pain (from which it is impossible to divert the patient's attention)	maximal pain (intolerable pain)
Regensteiner	0	1	2	3	4
	no pain	onset claudication	mild pain	moderate pain	severe pain

Pain scale according to AW Gardner et al.[14] on the basis of the American Collage of Sport Medicine (ACSM)[25] and J.G. Regensteiner et al.[26]

tained. The authors, in emphasising the advantages of the test, point out the good correlation with the protocol developed by Hiatt et al.[18] (r=0.89 for ACD and r=0.90 for VO_2 max). Besides, they point to the high ICC value of the proposed test representing 0.96 for ICD, 0.98 for ACD as well as 0.97 for VO_2max.

It is equally shown that the subsequent evaluation of patients from the control group not subjected to treatment through the application of the gradual test did not display a significant increase in the walking distance (ICD or ACD), as was the case in the test with a constant load[14,29]. Such a stability in measurement makes a clinical interpretation of the research easier, for actual data on the walking possibilities of a patient limited by claudication are supplied[2,18]. Nevertheless, in a similar way to the application of the test with constant load, also here it follows to remember about the necessities for an earlier, practical familiarization on the part of the patient with the way of walking on a treadmill. It is evaluated that the size of the test group as equally that of the control group with the use of the test with increasing load should be no less than 22 patients in order to maintain reliable results[18]. However, the evaluation of progress in treatment expressed in the form of time increase or the distance walked becomes problematic as a result of the increasing load in the subsequent minutes of the test.

In conducting walking tests on a treadmill it follows to avoid patient handrail support so as to avoid significant reduction in the load on the lower limbs[30]. It is shown that although use of the rail does not influence the hemodynamic parameters it results in an inflating of the results (ICD and ACD) of the walking tests both with constant load as with an increasing one, and therefore it is recommended that the rails are used only as an element maintaining balance if this is necessary for patient safety[31]. In practice the patient may form his hand into a fist and simultaneously support himself on the rail with a solitary finger to maintain balance[30].

Walking test on a treadmill with increasing pain threshold speed (PTS). The test is conducted at a zero angle of treadmill incline. The initial speed is 1.5 km/h and undergoes an increase of 0.1 km/h every 10 metres. The speed at which lower limb muscle pain appears is evaluated, as well as the maximum speed i.e. the speed at which a patient refuses to make an effort as a result of the increasing pain experienced. The person conducting the test does not motivate the patient to continue the effort. The authors of the test[32] propose the simultaneous registering of the frequency of the heart rate (HR) at the end of every 10 metre section. The test is stopped also when the HR reaches the value of 80% of the maximum (in relation to age) HR and also for reasons different than vascular ones, which prevent walking at the desired speed. The results of the PTS test correlate well with the ICD values (r=0.83) of the treadmill test with an increasing load, as well as with a six-minute distance (r=0.72) and ABI (r=0.64). The authors of the test consider that it may be especially used to evaluate the results of rehabilitation in a group of patients with intermittent claudication. The PTS test may turn out to be a good research tool although it requires validation on a representative group of patients.

The ergometer cycle test. This test promoted by Gardner[33] for the evaluation of patients with intermittent claudication was relatively rarely used in this group of patients. The test is conducted at a frequency of 60 revolutions per minute, at an initial load of 20W maintained for 5 minutes. Subsequently the load was increased by 20W every 3 minutes until there was a refusal to continue the exertion as a result of the intensification of pain experienced. Askew et al.[34] in comparing the test on the ergometer cycle to the gradual test on the treadmill, note the small amount of variability within a group of patients with intermittent claudication (CV=7%) in relation to the treadmill test, where CV calculated on the basis of three subsequent tests was 16%. Besides, the authors did not find differences in the area of the maximum exertion values VO_2 and HR between the compared tests and consequently suggested that both tests are connected with a similar cardio-vascular and metabolic load. However, there was a significant difference in the maximum time of exertion/effort, which was close to 40% longer for the ergometer cycle. At the same time there was noted a strong correlation (r=0.85) between the maximum time of exertion/effort obtained on the ergometer cycle as well as in the gradual test on the treadmill.

Walking tests

6-Minute Walk Test. It owes its usability to the fact that this is not a time-consuming test, one that does not require specialist equipment as well as being well liked by the patients themselves – it does not arouse a sense of anxiety as well as aptly portraying the walking possibilities. It is considered that the exertion manifested during the test's realisation is more representative for day-to-day activity in comparison to other forms of testing e.g. a treadmill test[35] and that the results of the test (the total 6-minute walking distance) correlates with the results of the gradual test on the treadmill within the range of ICD (r=0.34), ACD (r=0.52) as well as the post-exertion ABI (r=0.55)[36].

The tested individual has as his task the covering of a flat surface, a corridor, for the greatest distance manageable in the course of six minutes, walking between two poles placed approximately 30 metres from each other. Evaluated are ICD, ACD as well as the complete (six-minute) distance walked. If the patient, before the elapsing of the six minutes, has to stop as a result of pain experienced in the lower limbs the ACD is noted and the patient rests until such time that they are able to continue the walk. The test ends with the completion of the six minutes. During the test the patient is verbally encouraged to walk (every two minutes), as well as encouraged to continue the walk while resting if this is necessary as a result of intensified pain in the muscles of the lower limbs[36,37]. A paedometer may also be used during the test to evaluate the total amount of steps taken[36]. Montgomery and Gardner[36] , in evaluating the usefulness of the six-minute walk test in a group of patients with intermittent claudication, estimate the ICC value to be 0.90 to 0.94 while Teixeira da Cunha-Filho et al.[38] evaluate the ICC for the six-minute test as 0.81 for ICD, 0.63 for ACD and 0.84 for the 6-minute distance walked, with the CV at 18%, 31,8%, and 20,3% respectively, which points, however, to a higher variability of results than those given by the team of Montgomery, Gardner[36] (CV in the range of 10-12%) nine years previously. This test appears, however, of little use in patients, for, with its relatively long walking distance, they do not obtain ACD before the elapsing of the six minutes, particularly in the evaluation of the effects of walking training on the treadmill. Such training is conducted as standard for three months at a constant speed of 3.2 km/h, and as a measure of progress in treatment the exertion load is increased through an increase in the incline angle of the treadmill[11]. Therefore, after the end of training, the patient may not sense the need to walk faster which will result in a small improvement in the six-minute distance walked.

Shuttle Walk Test. This was demonstrated for the first time in 1992 by Singh as a diagnostic instrument for patients with lung diseases[39]. During the test the patient covers a 10 metre section, there and back, marked out on a flat surface – a corridor, at a speed established by sounds emitted at an appropriate rhythm. The test may be carried out at a constant rate (4 km/h) or increasing (at an initial speed of 3 km/h, increasing by 0.5 km/h for every minute)[38]. The maximum time for the test duration is 12 minutes. The set parameters cover ICD, ACD, as well as the entire distance of the walk. The variability of this test is in the ACD measurement: 15.9% in the test with an increasing speed and 21.1% for the one with a constant speed[39]. However, Zwierska et al.[40] evaluate ICC respectively at 0.87 and 0.82. Different values are given by Teixeira da Culhna-Filho et al.[38] evaluating that in the test with increasing speed ICC is 0.72 for ICD as well as 0.90 for ACD, while they note CV at 26.8 % for ICD and 9.1% for ACD. The authors, in conducting a direct comparison with the six-minute test in the group of patients with intermittent claudication, show that the shuttle walk test is characterised by a higher ICC and the results obtained are characterised by a lower variability. The shuttle walk test is also an alternative for treadmill tests, it does not require specialist equipment or qualified personnel and may be conducted in almost any conditions. Zwierska et al.[40] , in comparing the shuttle walk test with the treadmill test with constant load, show that the shuttle walk test with increasing speed is characterised by the same reproducibility (ICC=0.87), besides it burdens the cardio-vascular system to a lesser degree (a lower increase in HR and blood pressure) and is preferred by patients.

Walking tests are widely popularised methods in the testing of patients with intermittent claudication. They are, however, not a sufficiently comprehensive tool for the evaluation of this patient group; for although they precisely define the change in the distance walked during treatment they do not evaluate the influence of this change on the daily functioning of the patient within the environment around him. There occurs, therefore, the need to use a method which would describe the patient's functional answer to the training programme employed[26].

Other functional tests and measurements of movement activity

Functional tests and the monitoring of movement activity may play a significant role in the characterisation of patient functional possibilities both before and after the application of treatment. As gait is the fundamental means by which a patient changes location, there are also added to functional tests the earlier mentioned walking tests conducted on a flat surface. Amongst the remaining patients with intermittent claudication the following found application:

Repeated Chair Rises. The patient is instructed to get up from a chair five times with arms crossed on the chest in the shortest time. The time taken for task completion is evaluated. McDermott et al.[41], Guralnik et al.[42] point to the good test reproducibility (ICC=0.73).

Standing Balance. The test assesses the patient's balance in three different positions: 1) standing with feet together, 2) standing with feet positioned parallel whereby the heel of one foot is positioned at the level of the toes of the second, 3) standing one foot after another in a single line. Each of the positions needs to be maintained for 10 se-conds[41]. The reproducibility of the test (ICC) is high and evaluated at 0.97[42].

Four-Meter Walking Velocity. During the test the patient covers a four-metre section: at a comfortable pace as well as as fast as possible. During the measurement at the comfortable pace the patient is instructed to walk at his/her normal speed 'like they would normally go shopping'[41]. The test is conducted twice for each of the speeds. The best result is used for the analysis.[42]. The test begins with the patient in a standing position, with feet together, and ends when the whole foot has crossed the finishing line[43]. The reproducibility of this test is high and represents 0.83 and 0.88 respectively for the measurement of the comfortable and maximum speed walk[44].

Short physical performance battery (SPPB). This is a combination of the above presented tests: getting up from a chair, balance standing as well as speed over a four-metre section. Each of these parts is given points from 0 (when the test is impossible for realisation) to 4 points. The maximum that may be obtained is 12 points[37,45,41]. SPPB is an objective measure of the function of the lower limbs, enabling the detecting of a risk in limitations appearing with regard to the carrying out of everyday activities, a lack of independence and the need for constant care[42,46].

Active pedal plantar flexion (APP). This was proposed by Harris et al.[47] for the evaluation of patients with intermittent claudication. The advantage of this method of evaluation involves first and foremost its ease in practical realisation in all conditions. McPhail et al.[48] in comparing the active pedal plantar flexion test with the test on the treadmill with constant load in patients with intermittent claudication points to a very high correlation (r=0.95) in the area of post exertion ABI. The test is conducted in a standing position. The authors propose the full scope of standing on one's toes, fifty times with knees unbent. After completion, the patient returns immediately to the starting position (without waiting). During the test, support with the thumbs against the wall with the aim of maintaining balance is permissible. Amirhamzeh et al.[49] propose that the standing on one's toes be carried out at the maximum tolerable speed rate (at least one act a second). The test is well liked by patients although its main limitation in evaluation are orthopaedic problems in the foot making the correct realisation of the test impossible.

Monitors of activeness. Daily physical activity may be measured by means of an accelerometer and paedometer, instruments estimating the subsequent quantity of used energy and the steps taken within the course of a whole day through a defined period of time – for example, several days, a week. The usefulness of these methods in the evaluation of patients with intermittent claudication has been noted by Sieminski et al.[53] as well as McDermott et al.[44,45] In using a Caltrac type accelerometer it has been claimed that intermittent claudication patient activity is over 40% lower than the activity of individuals of a similar age without claudication[39]. It is estimated that the ICC for the measurement of daily physical activity measured with an accelerator is 0.84 while 0.86 for the measurement of steps by means of a paedometer. Sieminski et al.[53] as well as Nasr et al.[54] point to, however, a moderate correlation between the average daily number of steps measured by means of a paedometer and ACD evaluated in a treadmill test (r=0.35), post exertion ABI (r=0.35), physical functioning (r=0.31) evaluated by the Short Form 36 questionnaire, as well as by the results of the Walking Impairment Questionnaire at r =0.42. It is noted that accelerometer and paedometer measurements providing objective data as to the physical activity of patients may serve in eliminating the inaccuracies appearing in the questionnaire tests.[26] There are proposed monitors enabling the simultaneous measurement of heart activity. Activity monitors of the Vitalog type enabling a simultaneous measurement of physical activity and the registration of ECG were used by Regensteiner et al.[26], while Coughlin et al.[55] propose the application of a Peripheral Arterial Disease Holter Control Device - (PADHOC) in the evaluation of the functional possibilities of patients with intermittent claudication, emphasising that this instrument enables the evaluation of various aspects connected with patient locomotion in the natural environment. At present the role of activity monitor may be also fulfilled by a Global Positioning System (GPS). Using GPS in the evaluation of daily locomotion, which was proposed by Le Faucheur et al.[9] in 2008, has to this day not found widespread use. Nonetheless the authors point to a high correlation (r=0.81) between the ACD measured in the treadmill test and the ACD registered by a GPS.

Strength testing and muscular endurance

Tests on the isometric strength of particular muscle groups of the lower limbs are the most often carried out[44]. There is research that talks of the significant correlation occurring between a lowered value of flexor and extensor strength for the hip joint as well as the knee joint flexors and a lowered value of the ABI indicator[50]. Together with the intensification of the ischaemia of the lower limbs the flexor strength of the intertarsal joint also diminishes[51]. Cameron et al.[52] proposed the use of an ergometer (Stresst'er ergometer) in the evaluation of the strength of the calf muscles. A patient in a lying position bends the foot plantarally against a 8.2 J resistance pressing down on the pedal of the ergometer at a recommended rhythm of 60 times a minute. The test was stopped after two minutes or as a result of an intensification in pain in the muscles of the tested limb. The number of repeats carried out was assessed. The authors point to a good correlation (r=0.69) between the result of this test and the ACD measured on the treadmill with constant resistance, as well as the post-exertion ABI (r=0.48). The device, despite its simplicity, has not seen widespread application. However, it seems that it could be useful in assessing patients with PAD of the lower limbs, for whom it is not possible to conduct walking tests as a result of the additional gait disorders (unconnected with claudication) as equally for those patients who have a systematic contra-indication for this type of exertion exercise. At present significantly more costly isokinetic chairs are used in the assessing of muscle stamina and strength, these are noted for their high reproducibility of measurements (ICC) in the range of 0.88 to 0.96[44]. As it is suggested that walking exercise leads to an increased activity of the muscles of the lower limbs[1], the testing of this form may be utilised in the evaluation by physical exercise of patients with intermittent claudication.

QUESTIONNAIRE

These serve the evaluation of patient health, his/her functional possibilities and quality of life. Here of significance are the patient's expectations directly connected with the concept of a satisfying quality of life. Quality of life is determined by many factors: socio-economic, domestic, interpersonal relations, satisfaction with work while the limitations experienced by patients as a result of their illness have an enormous influence on their lifestyle. It is therefore suggested that tests into quality of life should be equally included within traditional methods of assessing the results of rehabilitation in patients with PAD of the lower limbs[56]. In the evaluation of functional possibilities as equally the quality of life of those suffering from intermittent claudication there are also applied questionnaires specific for this problem as well as questionnaires serving to evaluate a general assessment of patient quality of life and the limitations resulting from the condition of health.

The Walking Impairment Questionnaire (WIQ) was devised by the team of Regensteiner, Hiatt[18] with the aim of assessing the results of treatment including the rehabilitation of patients suffering from intermittent claudication. It was also used to evaluate the changes in the locomotive possibilities of patients following varied exercises, operations applying peripheral arterial, pharmacological therapies[57,58]. The questionnaire determines the functional state, the patient possibilities and limitations with claudication during everyday activities. It is short and simple to use and with it the most specific questionnaire for the evaluation of the locomotive possibilities for patients with PAD of the lower limbs[59,60]. Composed of four parts assessing the subjective feelings of the patient in the form of degrees of pain intensification, experienced difficulties in the area of muscle pain of the lower limbs and other health problems limiting locomotive possibilities, as well as with regard to difficulties connected with distance, walking speed on a flat surface and climbing stairs[2,3,18]. The obtained results correlate (r=0.33) with the ACD measurement in the walking test with an increasing load, as equally being stable in the repeated testing conducted within the control group[2,3,18]. It is considered that WIQ is an accurate method for the evaluation of gait abilities within heterogenic groups of patients, both with claudication and without[61]. McDermott et al.[61] show that the results of the WIQ with regard to the walking distance correlate with those obtained in the six-minute test (r=0.55), while in relation to the speed of walking they correlate with the four-metre distance test both at a comfortable speed (r=0.52) as at the maximum (r=0.56). There is also pointed out the ACD correlation in the treadmill test with the WIQ results for the distance walked (r=0.58) and speed (r=0.67). McDermott et al.[61] as well as Coyne et al.[62] evaluate the questionnaire results for the speed of walking, the distance covered and climbing the stairs at 0.82–0.94. Difficulties may arise in European conditions with the imprecise American unit of 'block' being used in the questionnaire as a measure of distance covered by the patient. It seems that the adoption of 100 metres to represent 1 block, as used in the first Polish WIQ version, is the optimal solution[59].

Peripheral Arterial Disease Physical Activity Recall (PAD-PAR) serves to roughly calculate the estimated patient energy expenditure in the week preceding testing. The patient estimates the amount of time spent on a given daily activity (sleep, work, housework, rest) of various intensity: very little (0.9–2 MET), little (2.1–3 MET), average (3.1–5 MET) as well as a lot (5.1–7 MET)[18,59]. This questionnaire, appearing also as *Low Level Physical Activity Recall* (LOPAR)[63], was developed by the team of Regensteiner and Haskell[18] based on the initial version *The Seven Days Physical Activity Recall*[64,65] and modified to the needs of evaluating the low level of activity of those with intermittent claudication. The PAD-PAR questionnaire is not, however, a simple instrument to use, for a precise defining of the time devoted to various given activities in the course of 24 hours is a relatively difficult thing to do.

Besides the above mentioned questionnaires specifically for intermittent claudication in the 1990s there were also used the *Edinburgh Claudiation Questionnaire*, being an improved version of the *WHO/Rose Questionnaire*[66], and the *San Diego Claudication Questionnaire*, enabling the classification of patients depending on the nature of the complaint[45]. Relatively new questionnaires are *The Impact of PAD on Quality of Life Questionnaire* (PADQOL)[67], *Claudication Scale* (CLAU-S)[68], as well as the *Intermittent Claudication Questionnaire* (ICQ)[69], known also as the *Charing Cross Symptom Specific Claudication Questionnaire* (CCCQ)[70].

Short Form 36 (SF–36) is a questionnaire enabling a general evaluation of quality of life. It comprises 36 questions answered independently by the patient or with the help of the researcher. Not only is the daily physical functioning assessed but also the subjective sense of state of health taking into consideration psychic, emotional, social factors, pain vitality, the mood of the person tested[3,18,57]. In this way the 36 questions are grouped into 8 categories constituting the subject of the assessment. The results are expressed as a percentage with 100% constituting a lack of limitations in the evaluated category. Brazier et al.[71], in carrying out for the first time in 1992 a validation of the SF–36, indicate a high ICC in the range of 0.74 in the category 'social functioning' to 0.93 for the category 'physical functioning'. The questionnaire, tested on varied populations (individuals with diabetes, heart diseases and other chronic illnesses), is also a recommended research instrument to evaluate patients with vascular problems[1,72]. It is considered that the application of SF-36 in individuals with intermittent claudication supplies a comprehensive insight into the degree of disability experienced by the patient and connected with the illness[18,56].

Nottingham Health Profile (NHP) is an often used, particularly in European testing centres, two-part questionnaire serving the evaluation of quality of life[57]. The first section concerns the subjective perception of health problems connected with sleep, life energy, emotional reactions, sense of social isolation, functional possibilities as well as pain. In the second section are questions assessing the previously defined patient problems on his activity in everyday life (at work, during free time)[58]. Chetter et al.[73] evaluate that ICC for this questionnaire is from 0.8 in the category 'life energy' to 0.87 for 'physical mobility' and 'emotional reactions'. The questionnaire was successfully used with individuals suffering from vascular diseases both arterial as venous. It is, however, considered to be a less detailed testing instrument when compared to SF–36[72].

From amongst the many questionnaires serving a general evaluation of quality of life in a group of patients with intermittent claudication use has also been made of the *European Quality of Life Scale* (EuroQol)[71] and the *McMaster Heath Index Questionnaire* (MHIQ)[74].

CONCLUSION

Intermittent claudication does not only limit in a measured way the possibility of movement but also makes it difficult for a patient to participate in a full and active way in his/her personal, social and professional life. In assessing patients with intermittent claudication one cannot forget about the basic source for obtaining information on the patient: a reliably conducted interview incorporating additional illnesses (of the cardio-vascular system, the respiratory system, diabetes, degenerative disease of the peripheral joints, stenosis of the vertebral canal, discopathy), taking medicines, a history of smoking and all the other factors that could influence not only the problem of claudication but also the health and quality of life of the patient. It is the compiling of information that is the basis for correct diagnosis and intervention, as equally planning, monitoring of treatment and later evaluation. In the authors' view in the evaluation of a patient's functional possibility there should be employed a gradual treadmill test or a shuttle walk test with increasing walking speed, incorporating the 6-minute test supplemented by a subjective evaluation of the functional possibilities and quality of life by means of the WIQ and SF–36 questionnaires. This view remains in accordance with the current international TASC II guidelines[11]. For certain, an assessment of those with intermittent claudication cannot be limited merely to an ABI measurement and the measurement of distance walked, for as Housley correctly pointed out[75] different will be the expectations in relation to the walking possibilities of a retired patient using a car and different again for someone working with a 2 km walk to work. The testing of patients with intermittent claudication should encompass a wide spectrum of testing methods describing both the degree of disease advancement from the medical viewpoint as equally the level of the patient's daily functioning taking into consideration the influence of the disease on difficulties experienced in day-to-day life, social and professional life.

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